

Serial No.: 10/720,173
Docket No.: 102-1003
Amendment dated February 1, 2007
Reply to the Office Action of November 2, 2006

Amendments to the Claims

The listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Previously Presented) An inkjet printer head driving apparatus having a plurality of heating elements and nozzles, comprising:

a switching unit turning on and off each of the heating elements to heat ink corresponding to selected nozzles to eject the ink;

a level shift unit having a level converter converting a potential level of a signal inputted therein into a predetermined potential level to drive the switching unit, a buffer to output the converted level of the signal, and a transient time extending part provided with at least one time extending element to extend by a predetermined time a transient time of the output potential level of the signal during which the potential level of the signal inputted from the level converter to the switching unit is converted from a first signal level to a second signal level and vice versa; and

a control unit receiving an external data signal, decoding the received data signal, and outputting the decoded data signal as a nozzle selection signal to the level shift unit to select the selected nozzles corresponding to a to-be-recorded image from the nozzles.

2. (Original) The inkjet printer head driving apparatus as claimed in claim 1, further comprising a discharging part discharging a residual voltage of a signal inputted from the level shift unit to a gate of the switching unit if the switching unit switching on and off the heating elements is turned off.

3. (Original) The inkjet printer head driving apparatus as claimed in claim 2, wherein the discharging part comprises:

a first logic device connected to receive an output signal of the level converter and an output signal of the transient time extending part;

a third inverter receiving an output signal of the first logic device and having an output

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terminal; and

a third NMOS connected to receive an output signal of the third inverter, and having a gate connected to the output terminal of the third inverter, a drain connected to an input terminal of the switching unit, and a source connected to a ground.

4. (Original) The inkjet printer head driving apparatus as claimed in claim 1, wherein the transient time extending part comprises:
a first inverter inverting the signal outputted from the level converter; and
a second inverter extending the transient time from the first signal level to the second signal level or a second transient time from the second signal level to the first signal level in correspondence to an output signal of the first inverter.

5. (Original) The inkjet printer head driving apparatus as claimed in claim 4, wherein the second inverter comprises:
a first PMOS having a source connected to a voltage supply and a gate and a drain commonly connected to each other;
a second PMOS having a source connected to the drain of the first PMOS and a gate connected to an output terminal of the first inverter;
a first NMOS having a gate commonly connected to the gate of the second PMOS and a drain connected to the drain of the second PMOS to form an output terminal of the second inverter; and
a second NMOS having a drain and a gate commonly connected to the source of the first NMOS and a source connected to ground.

6. (Previously Presented) A control method of an inkjet printer head driving apparatus having a switching unit driving heating elements corresponding to selected nozzles to eject ink through selected nozzles, comprising:
outputting a nozzle selection signal to select nozzles corresponding to a to-be-recorded image out of the plural nozzles;
receiving an inputted signal corresponding to the nozzle selection signal, converting a

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level of the inputted signal to a predetermined potential level to drive the switching unit, and outputting the converted level of the inputted signal;

extending a transient time of the output level of the inputted signal by a predetermined time in accordance with an output signal generating when the level of the inputted signal is converted, the transient time being a time period during which the level is converted from a first signal level to a second signal level and vice versa; and

driving the heating elements corresponding to the selected nozzles to eject the ink through the selected nozzles based on the output signal from the transient time extending operation.

7. (Original) The control method as claimed in claim 6, wherein the extending of the transient time comprises:

extending a first transient time during which the first signal level is converted to the second signal level; and

extending a second transient time during which the second signal level is converted to the first signal level.

8. (Previously Presented) An inkjet printer head driving apparatus having a plurality of heating elements and nozzles, comprising:

a control unit generating a control nozzle selection signal to select a heating element and a nozzle corresponding to an image to be printed;

a level shift unit generating a first nozzle selection signal having a first transient time, during which a level of the first nozzle selection signal is changed between first and second levels, in response to the control nozzle selection signal, and generating a second nozzle selection signal having a second transient time extended by a period from the first transient time of the first nozzle selection signal; and

a switching unit turning on and off the heating element according to the second nozzle selection signal.

9. (Original) The inkjet printer head driving apparatus as claimed in claim 8, further

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comprising:

a discharging part discharging a residual voltage of the switching unit according to the first nozzle selection signal and/or the second nozzle selection signal.

10. (Original) The inkjet printer head driving apparatus as claimed in claim 9, wherein the switching unit comprises a transistor having a first terminal coupled to the level shift unit and the discharging part, a second terminal coupled to the heating element, and a third terminal connected to a potential, and the residual voltage of the switching unit is a voltage of the first terminal.

11. (Previously Presented) The inkjet printer head driving apparatus as claimed in claim 9, wherein the discharging part is coupled to the level shift unit to receive the first and second nozzle selection signal so that the residual voltage of the switching unit is discharged according to at least one of the first transient time of the first nozzle selection signal and the second transient time of the second nozzle selection signal when the switching unit is turned on and/or off according to the second nozzle selection signal.

12. (Original) The inkjet printer head driving apparatus as claimed in claim 8, wherein the first transient time of the first nozzle selection signal comprises a first rising transient time and a first falling transient time, during which the level of the first nozzle selection signal is changed between the first and second levels, in response to the control nozzle selection signal, and the second transient time of the second nozzle selection signal comprises a second rising transient time and a second falling transient time, during which a level of the second nozzle selection signal is changed between third and fourth levels, extended by first and second periods from the first rising transient time and the first falling transient time, respectively.

13. (Original) The inkjet printer head driving apparatus as claimed in claim 12, wherein the second rising and falling transient times are longer than the first rising and falling transient times, respectively.

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14. (Original) The inkjet printer head driving apparatus as claimed in claim 8, wherein the second transient time of the second nozzle selection signal has a period longer than that of the first transient time of the first nozzle selection signal.

15. (Original) The inkjet printer head driving apparatus as claimed in claim 8, wherein the second nozzle selection signal comprises a transient level disposed between the third and fourth levels during the second transient time, and the transient level comprises a first sub-transient level and a second sub-transient level.

16. (Original) The inkjet printer head driving apparatus as claimed in claim 15, wherein one of the first and second sub-transient levels of the transient level of the second nozzle selection signal has a period longer than the first transient time of the first nozzle selection signal.

17. (Original) The inkjet printer head driving apparatus as claimed in claim 15, further comprising:

a discharging part discharging a residual voltage of the switching unit according to the first nozzle selection signal and/or the second nozzle selection signal, wherein the switching unit is turned off according to the second nozzle selection signal while the discharging part discharges the residual voltage of the switching unit according to the first transient time of the first nozzle selection signal.

18. (Original) The inkjet printer head driving apparatus as claimed in claim 15, wherein the first sub-transient level is not linear between the first level and the second sub-transient level, and the second sub-transient level is linear between the first sub-transient level and the second level.

19. (Original) The inkjet printer head driving apparatus as claimed in claim 8, further comprising:

a discharging part coupled to the level shift unit to receive the first and second nozzle

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selection signals to discharge a residual voltage of the switching unit according to the first nozzle selection signal and/or the second nozzle selection signal, wherein the first nozzle selection signal comprises a previous first nozzle selection signal and a current first nozzle selection signal, and the second nozzle selection signal comprises a previous second nozzle selection signal and a current second nozzle selection signal corresponding to the previous first nozzle selection signal and the current first nozzle selection signal of the first nozzle selection signal, respectively, and the voltage of the switching unit is a residual voltage remaining in the switching unit when the switching unit is turned off according to the previous second nozzle selection signal.

20. (Original) The inkjet printer head driving apparatus as claimed in claim 19, wherein the voltage of the switching unit is another residual voltage remaining in the switching unit when the switching unit is turned off according to the current second nozzle selection signal.

21. (Original) The inkjet printer head driving apparatus as claimed in claim 8, wherein the first nozzle selection signal comprises a first rising transient time and a first falling transient times disposed between the first and second levels, the second nozzle selection signal comprises third and fourth levels and second rising and falling transient times disposed between the third and fourth levels, and the third level of the second nozzle selection signal is disposed between the second rising and falling transient times of the second nozzle selection signal and has a period shorter than that of the first level of the first nozzle selection signal disposed between the first rising and falling transient times of the first nozzle selection signal.

22. (Original) The inkjet printer head driving apparatus as claimed in claim 21, further comprising:

a discharging part coupled to the level shift unit to receive the first and second nozzle selection signals to discharge a residual voltage of the switching unit according to the second rising transient times of the second nozzle selection signal before the switching unit is turned on according to one of the third and fourth levels of the second nozzle selection signal.

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23. (Original) The inkjet printer head driving apparatus as claimed in claim 22, wherein the discharging part discharges the residual voltage of the switching unit according to the second rising transient times of the second nozzle selection signal before the switching unit is turned off according to one of the third and fourth levels of the second nozzle selection signal.

24. (Original) The inkjet printer head driving apparatus as claimed in claim 8, wherein the switching unit comprises an FET, and a turning-on time of the FET is delayed by the period during which the first transient time of the first nozzle selection signal is extended to the second transient time of the second nozzle selection signal, to provide a sufficient time to charge and discharge a parasitic capacitance around the FET.

25. (Original) The inkjet printer head driving apparatus as claimed in claim 8, wherein the control nozzle selection signal comprises on and off signals to turn on and off the switching unit corresponding to the heating element, the level shift unit comprises a level converter to convert the control nozzle selection signal into the first nozzle selection signal having the first and second levels which are different from the on and off signals in signal level, respectively.

26. (Original) The inkjet printer head driving apparatus as claimed in claim 25, wherein a time taken to convert the on and off signal of the control nozzle selection signal into the first and second levels of the first nozzle selection signal is compensated by extending the first transient time of the first nozzle selection signal to the second transient time disposed between third and fourth levels of the second nozzle selection signal which correspond to the first and second levels of the first nozzle selection signal, respectively.

27. (Original) The inkjet printer head driving apparatus as claimed in claim 26, wherein the switching unit is turned on according to the fourth level of the second nozzle selection signal, and a time period of the fourth level of the second nozzle selection signal is shorter than that of the second level of the first nozzle selection signal.

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28. (Original) The inkjet printer head driving apparatus as claimed in claim 26, wherein a total period of the second transient time and the fourth level of the second nozzle selection signal is the same as that of the first transient time and the second level of the first nozzle selection signal.

29. (Original) The inkjet printer head driving apparatus as claimed in claim 26, further comprising:

a discharging part discharging a residual voltage of the switching unit according to the first and second nozzle selection signals.

30. (Original) The inkjet head driving apparatus as claimed in claim 29, wherein the discharging part is changed between a turned-on state and a turned off state during a portion of the second transient time of the second nozzle selection signal to discharge the residual voltage of the switching unit and/or stop discharging the residual voltage of the switching unit according to the third level of the second nozzle selection signal.

31. (Previously Presented) An inkjet head driving unit, comprising:
a control unit to generate a nozzle selection signal to select a nozzle having a heating element;

a level shift unit to convert the nozzle selection signal to have a predetermined level to drive the heating element between a logic high and a logic low, and having a buffer to output the converted nozzle selection signal, and one or more logic units to increase a time required to change the output nozzle selection signal between the logic high and the logic low; and

a switching unit to turn the heating element on and off according to the output of the level shift unit.